MODULATION OF THE BRAIN ACTIVITIES DURING 3D OBJECT PERCEPTION FROM 2D OPTIC FLOW

S. Iwaki¹, and J. W. Belliveau²
¹National Institute of Advanced Industrial Science and Technology (AIST), Ikeda, Osaka, Japan, ²Massachusetts General Hospital, Boston, MA, United States

Introduction

Two dimensional optic flow is a strong cue to reconstruct the shape of the 3D object in motion. Recent studies revealed the involvement of the parieto-occipital junction (POJ), the intra-parietal (IP), and the ventral posterior inferior-temporal (pIT) areas as well as the motion sensitive area MT in the perception of 3D structure from 2D motion of random-dots (3D-SFM) [1]. In this study, we parametrically controlled the coherence of the random-dot motion to elucidate the changes of the brain activities in these regions between different 3D percepts.

Methods

Eight normal right-handed healthy subjects (22-43 years) were participated in the study. The visual stimuli consisted of 1000 random dots. The coherence of the motion was controlled from 0 to 100 %. A stimulus that is fully (100 %) coherent had all the dots moving as if they belonged to a rotating spherical surface with a radius of 10 degree in visual angle which generates robust percepts of a rotating sphere. The other conditions, the 80, 60, 40, 20, and 0 % coherence conditions, contain dots having the same speed as the fully coherent stimuli but the directions of the 20, 40, 60, 80, and 100 % of the dots were randomized, respectively.

The fMRI scanning was conducted using a 3 Tesla MR scanner. For functional imaging, the single shot echo-planer imaging sequence was used with the imaging parameters TR 3000 ms, TE 40 ms, FA 90 deg, 40 axial slices, 3 mm thickness, 64x64 matrix, and FOV 220 mm, which covered the entire brain. Three 14-min functional scans were divided into 12 s phases, randomly alternating between different stimulus conditions and resting periods. Within each phase, motion stimuli were presented every 4 s.

Results

Subjects’ response collected during the fMRI sessions showed that the perception of 3-D structure was dominant in the 80 and 100 % conditions whereas 3-D object was rarely perceived in the 0 and 20 % conditions (Fig. 1). Figure 2 shows the results of the fMRI group statistics, in which fMRI contrasts between the 3-D perception condition (100 and 80 % coherent conditions) vs. the random motion condition (0 and 20 % coherent conditions) were depicted. Significant increases of BOLD signal were observed in the MT, POJ, IP, and pIT regions in the 3-D perception condition.

Discussion

The change in the activation in the MT area in conjunction with the perception of global motion is also reported in the previous fMRI studies [2], and the IP area was reported to be activated during the mental imagery processing [3], which suggests that the perception of moving 3-D object from 2-D motion includes both perception of global motion and 3-D mental image processing, that are accomplished by the cooperative activation in the ventral and dorsal visual pathways. The decreased activities in V1 possibly reflect the activation of V1 neurons with a wider range of motion selectivities and smaller receptive fields compared to neurons in extra-striate regions [4].

References